**Manhattan Project**

Wrote by Yakovlev Sergey

Responsible examiner – Alla Nazarenko

*For Moscow State University*

*2017*

Оглавление

[**Introduction** 3](#_Toc484121765)

[**1.** **Project origins** 3](#_Toc484121766)

[**2.** **The principles of nuclear weaponry** 4](#_Toc484121767)

[**3.** **Project organization** 5](#_Toc484121768)

[**4.** **First tests** 7](#_Toc484121769)

[**5.** **Was the threat of German nuclear bomb real at all?** 8](#_Toc484121770)

[**6.** **Bombing of Hiroshima and Nagasaki** 9](#_Toc484121771)

[**7.** **Aftermaths** 10](#_Toc484121772)

[**Conclusions** 10](#_Toc484121773)

[**Sources** 11](#_Toc484121774)

# **Introduction**

For a long history of humanity there were several major steps in making new fundamental discoveries. Starting from obtaining the fire and creation of wheel straight to the developing of electricity infrastructure and invention of radio. Today we can hear many talks about computer revolution and wide spread of the internet. And often we forgot that probably an even more important invention was made only a little more than a half century ago. There is a reason for that.

It is a good thing to know that today a nuclear weapons rarely become a hot topic for a news agencies. It’s a common thing today to know that humanity can control the power of radioactive decay. We all know that nuclear weapon exists. It is hidden somewhere, locked in a silos. It is hard to believe that only several decades ago most part of humanity lived in everyday fear of nuclear war. Political situation have changed drastically since that days. But principle threat of nuclear confrontation still remains. So it’s a good thing to remember how did it started. How the man obtained the power of radioactive decay.

Manhattan project was a border line, a point of no return when the nuclear power manifested its presence to the world. This short report will help you to follow the main steps of nuclear progress.

1. **Project origins**

The situation in science community before World War II and before Manhattan project was totally different than today. In brief there were no restrictions for connections between scientists from different countries. International science magazines always published the results of almost every invention and experiment in every sphere of science. So the scientists from all over the world can work together – they read articles, gave advices and proposals, shared information and hypothesis. It was a team work. And it was beneficial for all the participants. The science was opened for all interested people. So the basic knowledge about radioactivity, discovered by such scientists as Henri Becquerel and the Curie pair, was a widespread thing.

Things became different in mid 30-s. Since the Nazis came to power in Germany and in time occupied several allied countries, they started anti-Semitic campaigns against all kinds of Jewish people. So many of them left their homes in that countries and moved to US. Among them there were several famous physicians and mathematics such as Albert Einstein and Leonard Szilard. They continued to develop their science projects about nuclear researches.

The more they progressed during that researches the more they realized possibility of creation of fundamental new kind of weapon with overwhelming firepower and outturn. At the same time they reialized that their colleagues from Nazi Germany could came to the same conclusions because whole data about nuclear researches was available for anyone. With increased alarm Leonard Szilard observed german science magazines and saw indications that it is very possible for nazi physicians to came to idea about nuclear weaponry.

Worried about this things they wrote a letter to the US president Roosvelt informing them about possibility of obtaining by the Third Reich the new powerful weapon. After several consultations with famous US scientists the White House decided to start a special project aiming to advance Third Reich an obtaining the nuclear bomb. The name of that project was – Manhatten Project.

# **The principles of nuclear weaponry**

From the very beginning it was perfectly clear that the project will consume immense amount of different resources. Another problem rooted from the innovate idea itself. There were no any useful experience or previous plans or acceptable schemes about such kind of projects at all. Like every real discovery, everything should be done from scratch. Thus, the success will be possible only under tight control of organized government organization with all sorts of human, technical and natural resources.

The core principle of nuclear weaponry was creating a special bomb containing a strict mass of radioactive uranium.

Even estimated calculations revealed that creating even a single bomb would require a significant mass of radioactive uranium. This create a problem for constructors because of several reasons. At first, uranium is a relatively rare chemical element. So one of the starting steps was extraction and accumulation of this sparse metal. In addition, US intelligence reported about the same procedures occurring at the same time in the Third Reich. This information of course intensify US government’s efforts in developing the project.

Secondly, the scientists were absolutely unanimous that ordinary and most common uranium is an improper source for a nuclear bomb. The nature of radioactive elements allows existing several similar kinds of the same element with slightly different properties. And this “slight” distinctions were a key points for constructing the bomb.

So the scientists needed not the ordinary uranium. Then what kind of uranium did they really needed? And why then they agreed to accumulate a great amounts of inconvenient uranium? The answer was that the scientists discovered the method to transform common Uranium into it special form (known as isotope, every radioactive element has isotopes) Uranium235 which can be used in a nuclear bomb. This process was slow and very resource-consuming. But there were no other choice.

Moreover several scientists argued about even more powerfull source for a nuclear bomb. They came to conclusions that a chemical element Plutonium was a more proper origin for this new weapon. Unfortunately Plutonium was even more rare element than Uranium235. It can be also obtained through recycling of ordinary Uranium but this process was even more complicated and complexed. Forestalling our story it can be said that the first nuclear bombs contained Uranium235 (i.e. Uranium bombs) as the source of explosive energy. But in the future Plutonium bombs became the second step in evolution of nuclear weaponry. So the scientists were right about their forecasts. The US governments believed them and were building appropriate infrastructure together with Uranium235-based reactors and factories.

One of the last main resource for this project was a special liquid called “Heavy water”. As you can expect through it’s name this liquid is a unique and rare form of water (as you can notice, almost every resource for this project was rare and unique). Heavy water was needed for Uranium enrichment (along with other ways to use) – the process of increasing the proportion of Uranium235 in ordinary Uranium. Another cause of concern for US government was that after occupation of Norway Third Reich took control over Norwegian heavy water plants. Less and less doubts remained that Hitler did really wanted to make a nuclear weapon.

Now you can see the picture of this great challenge and all its risks.

# **Project organization**

The scale of works that should be done according to project plans by designers, builders and scientists, was truly immense.

Here is only a short list of necessary facilities for Manhattan Project:

* Large number of special centrifuges for enrichments of uranium;
* Designing the schemes of these centrifuges (because there were no any of them at the time of starting the project) along with schemes of the bomb itself;
* The special safe warehouses for uranium and plutonium deposition
* Big science laboratory in a distant region with low population for a planned test explosions;
* Many special plants and factories all across the country for producing different parts of the bomb;
* At last US Government decided to build a whole new city called Oak Ridge for maintaining many of these numerous facilities and it’s workers.

On this map you can see the geographical scale of the project:



Just look at the bare figures of this project:

* 129 000 employers of all professions were involved in the project
* 6000 military persons helped scientists to operate the bomb and maintain it
* Total project expenses were about 1.9 billion dollars. See this table for more information

|  |  |  |  |
| --- | --- | --- | --- |
| **Site** | **Cost (1945 USD)** | **Cost (2016 USD)** | **% of total** |
| Oak Ridge | $1.19 billion | $15.8 billion | 62.9% |
| Hanford | $390 million | $5.19 billion | 20.6% |
| Special operating materials | $103 million | $1.38 billion | 5.5% |
| Los Alamos | $74.1 million | $985 million | 3.9% |
| Research and development | $69.7 million | $927 million | 3.7% |
| Government overhead | $37.3 million | $496 million | 2.0% |
| Heavy water plants | $26.8 million | $356 million | 1.4% |
| **Total** | **$1.89 billion** | **$25.1 billion** |  |

Now you can imagine the scale of the project. How complexed and sophisticated it was. So you shouldn’t be surprised that from the beginning of the project the US government tried to join its efforts with allies. Scientists from United Kingdom, Canada, France and many other European countries (even migrants from Germany!) joined their forces with US colleagues trying to accelerate the project implementation.

Allied countries also helped to finance the building works, shared their intelligence information and even conducted military operations in attempt to impede the nuclear researches in Third Reich.

1. **First tests**

As the the efforts made were that intense the first test bomb was ready in the beginning of the 1945. There were some speculations about real necessity of these tests. As you already know both uranium235 and plutonium resources were limited. So wasting them on test explosions considered by part of scientists as useless actions.

Anyway, the US responsibility about this project was so high that the risk of failure was unacceptable. In addition, the complexity of new weapon was unprecedented so it was decided that, despite the waste of fissile material, an initial test would be required.

The military and scientists designed and constructed special test site in a remote area of New-Mexico desert. The project team planned to gather a lot of precious data from this test which could help to improve the bomb. In order to compare the effects of explosions from different types of weapon the first test conducted conventional bomb. According to science calculations this TNT-made bomb was equivalent to a new nuclear one. So it would be more simple to understand the firepower of new weaponry.

The main test of first nuclear device was called “Trinity”. It took place on the 16 of July 1945. The test bomb was named “The Gadjet” and exploded in the desert in 5:29 PM.

Many persons witnessed the explosions from military representatives of all sorts and members of science crew to journalists and government officials. The devastating results of this test can be best described by impressions of Robert Oppenhaimer – the director of the Manhattan Project:

“We knew the world would not be the same. A few people laughed, a few people cried. Most people were silent. I remembered the line from the Hindu scripture, the Bhagavad Gita; Vishnu is trying to persuade the Prince that he should do his duty and, to impress him, takes on his multi-armed form and says, 'Now I am become Death, the destroyer of worlds.' I suppose we all thought that, one way or another.”

1. **Was the threat of German nuclear bomb real at all?**

As the war goes it was more and more obvious that Hitler couldn’t afford Germany to have such a weapon. More conducted intelligence operations revealed that Germany even didn’t had any war nuclear projects at all. German scientists were way behind their colleagues from US in understanding the advantages of controlled nuclear decay. The Germany never had anything similar to the Manhattan Project. The Hitler was more concerned about conventional weapons like missiles or tanks. Risky innovative projects with doubtable outcome were not welcome. All accumulated uranium was never used in Third Reich and after surrender of the Nazis it was confiscated and taken away.

Thus the main threat that forced Einstein and Szilard to ring the bell disappeared.

Anyway the US government already had the most powerful weapon in the world. And after results of the Trinity test it was quite obvious that the devastating power of this new weapon was truly immense. There was no turning back. No one will refuse to has such a weapon after obtaining it. Thus the real bombing became only a matter of time.

It should be mentioned that as US government made sure about absence of nuclear program in Germany they hided this information from science team. They reasonably believed that the threat of Nazi bomb will encourage people to work harder. Moreover US officials suspected that if the information about that will become a well-known fact someone will want to sabotage the project. Clues to those conclusions really existed. Because of the great importance of the nuclear program all the members of science teams were subject for intelligence surveillance. And the results of this surveillance showed that many scientists were concerned about creation of such a powerful weapon. Others even sympathized to pacifistic or socialistic ideas. US officials feared that without strong external threat the part of the scientists would drop out from the project.

After Nazi’s surrender it was impossible to hide the truth any longer. Scientists begin to try to stop the future development of the project. But it was too late. The weapon was already created.

1. **Bombing of Hiroshima and Nagasaki**

As you might know the relations between Allies and Soviet Union got much worse in the end of war. The western countries started to fear the possibility of spreading of socialistic ideas among their population along with possible intrusions of Red Army. Many US politicians were sure that the real stand between ex-allies only begin.

In this light, the US government was assured that demonstration of the power of nuclear weaponry will bring fear to Soviet Union and will make its representatives more pliable during diplomatic negotiations.

The only reasonable target for bombing remained on the Pacific theater of operations. The Japan slowly but surely loose the war against US both in marine battles, air clashes and in ground operations. The US fleet stood right in front of the hurt of Japan Empire – the islands of Japan. Nevertheless taking into account previous persistent resistance of japan army the US generals forecasted long and bloody battles if the landing troops will be used for invasion.

So the US officials decided to kill two birds with one shot. They decided to enforce Japan to surrender without landing troops to Tokyo by bombing several its objects and at the same time to show to the Soviet Union the devastating power of new weapon.

After several consultations the military and scientific experts choose possible candidates for bombing. Because of the massive effect of nuclear weapon the only reasonable target for a bomb with that firepower should be a size of not less than a whole town.

On 6 August 1945 first bomb was dropped on Hiroshima city. Three days later (9 August) the second one was dropped on Nagasaki city.

The world had changed after those days forever.

Estimated calculations claimed 90,000–146,000 people in Hiroshima and 39,000–80,000 in Nagasaki were killed by the bombings. Fires followed after the explosions destroyed each city. Thousands people suffered from radiation sickness later. Witnessing the devastating power of these bombings terrified Japan government agreed to surrender.

1. **Aftermaths**

Finally the war was over and the United States was the only country with this new weapon. Flames of Hiroshima and Nagasaki fade but the real age of nuclear fire only began. US intelligence reported about intense activity of Soviet nuclear program. US officials were sure that at least all next decade they would be the only operators of nuclear devices. They were mistaken.

In July 1945 (before Japan attacks), a group of concerned scientists prepared a special report to the US officials called “Franck Report” (James Franck was the head of committee that produced this report). The main point of that report was a recommendation to US government not to use the atomic bomb as the weapon to prompt surrender of Japan. The authors warned government about impossibility to keep the United States atomic discoveries secret indefinitely. They predicted a nuclear arms race, forcing the United States to develop nuclear armaments at such a pace that no other nation would think of attacking first from fear of overwhelming retaliation. The report recommended that the nuclear bomb not be used, and proposed that either a demonstration of the "new weapon" be made before the eyes of representatives of all of the United Nations, on a barren island or desert, or to try to keep the existence of the nuclear bomb secret for as long as possible.

Later on big parts of that report became real as the concept of mutual assured destruction became a major factor in the Cold War along with spreading of nuclear weapons to other countries.

After the presentation, the report was classified and closed to the public attention. All its points were discarded by the military and the bombings occurred by schedule. The scientists were not useful or needed any more. Their job was already done.

The world has entered into a new era. The era of nuclear fear.

**Conclusions**

It is not uncommon that new invention is used as the weapon at first but later on become useful in peace aspects also. Today the nuclear reactors generate a significant part of electricity in the world. Radiation therapy helps many people all over the world to prevent cancer deceases. Plutonium-based portable generators feeds distant space spacecrafts. There are hopes that the developing reaction of cold fusion will once free humanity from energy shortage. All this could become real because of Manhattan Project. After all, the world have survived the stressful Cold War and we can hope that the mankind still could use new inventions for the peace but not for the war.

# **Sources**

1. Michael Ruse “Robert Oppenheimer and the atomic bomb”, Atomizdat, 1965.
2. Robert Jungk “Brighter than a Thousand Suns: A Personal History of the Atomic Scientists”, Gosatomizdat, 1961.